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THE NEW YORK STATE BARGE CANAL*

By WILFRED H. SCHOFF
Secretary, The Commercial Museum, Philadelphia

The object of the barge canal system is to provide navigation connecting New York Harbor at tide level with Lake Champlain 96.5 feet above sea-level, Lake Ontario 244.4 feet and with Lake Erie 573 feet. Connection between the ocean and the canal proper is made by the Hudson River, which is, geologically speaking, a drowned valley or tidal estuary as far as Hudson, the delta formations of the river being found between Hudson and the natural falls near Troy, long ago submerged by the State dam at that city.

The Federal Government is now at work on a channel improvement project on the upper Hudson, designed to provide a uniform depth of 12 feet between Hudson and the Troy dam. At Troy this project includes the construction of a great concrete dam spanning the river at Troy, with a single lock at the eastern bank of 15 feet lift. The lock dimensions are 492 feet long, 45 feet wide and 14 feet deep. Into the pool created by the Troy dam, which provides 12 feet depth as far as Waterford, the northern terminus of the Federal project, both the Champlain and the Erie Canals will discharge their traffic. The Champlain branch will connect the Troy dam with the Narrows of Lake Champlain at Whitehall. The length of this waterway is 61.5 miles, and the plan provides for abandonment of a large part of the old Champlain Canal and for canalization of the Hudson River by utilizing existing dams. This branch has eleven locks. It ascends from the Waterford pool to a summit level between Fort Edward and Fort Ann 125 feet above the pool, or 140 feet above tide water. Thence it descends 43.5 feet to the Lake Champlain level.

This lake, being an interstate waterway, is also under the jurisdiction of the Federal Government, and before a uniform 12 foot depth can be had between the barge canal and Canadian waters, further improvement of the Champlain Narrows will be necessary. This work is partly provided for under existing Federal legislation, and it is anticipated that more active work will be undertaken whenever the political controversy over River and Harbor bills shall have been adjusted.

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* Continued from pp. 321-333, May *Bulletin*.

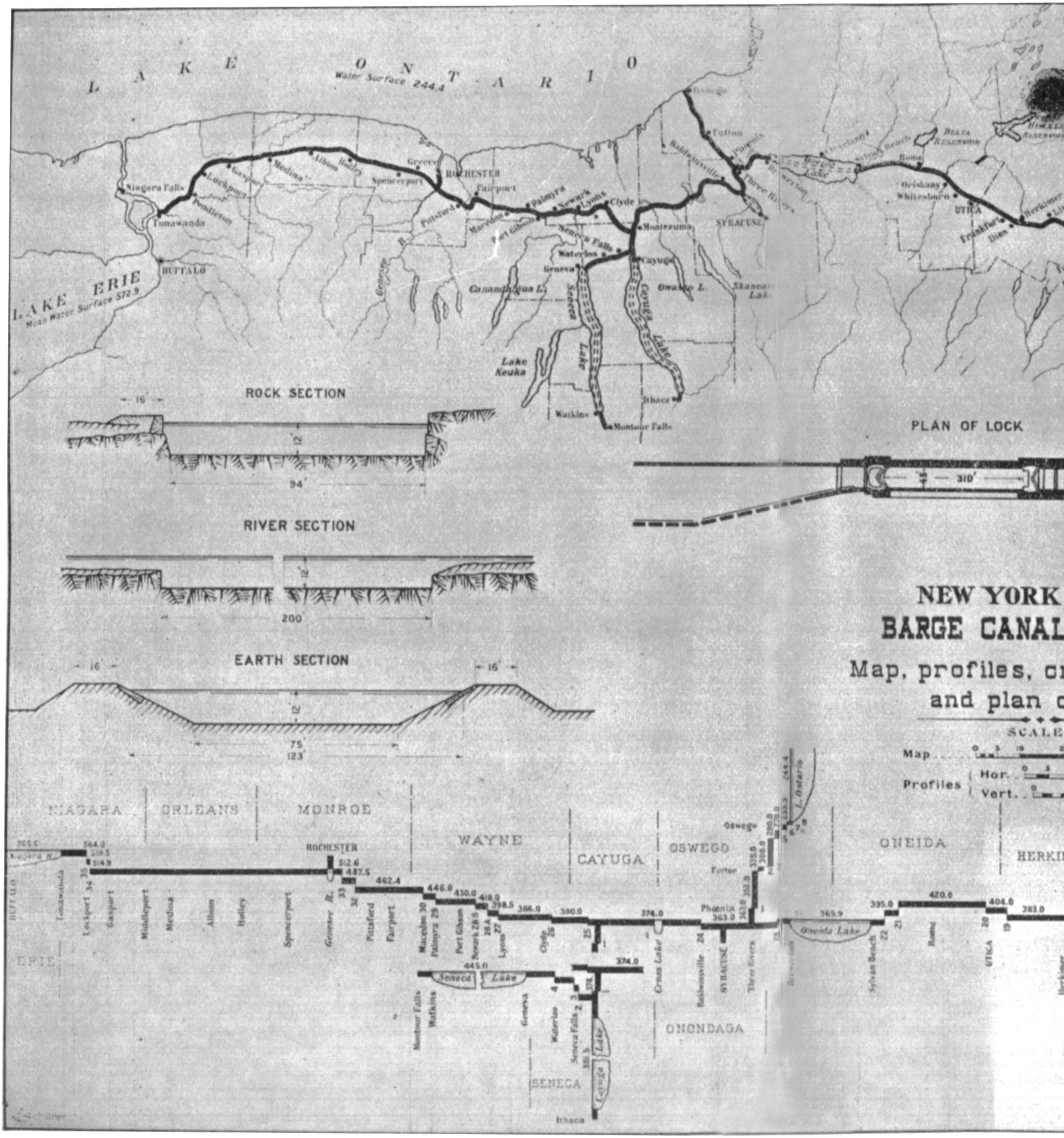

NEW YORK
BARGE CANAL
Map, profiles, c
and plan o
SCALE
Map
Profiles
Hor.
Vert.
LAKE ONTARIO
Water Surface 244.4
LAKE ERIE
Mean Water Surface 572.9
Niagara Falls
Tonawanda
BUFFALO
Lockport
Pendleton
Gasport
Medina
Albion
Holley
Spencerport
Greece
ROCHESTER
Fairport
Pittsford
Macedon
Port Gibson
Palmyra
Newark
Lyons
Clyde
Montezuma
Seneca Falls
Waterloo
Geneva
Cayuga
Canandaigua L.
Seneca Lake
Cayuga Lake
Owasco L.
Skaneateles Lake
Lake Keuka
Watkins
Montour Falls
Ithaca
Genesee R.
SYRACUSE
Baldwinsville
Three Rivers
Phoenix
Fulton
Oswego
Brewerton
Oneida Lake
Cleveland
Sylvan Beach
Rome
Delta Reservoir
Oriskany
Whitesboro
UTICA
Frankfort
Ilion
Herkimer
ROCK SECTION
16'
12'
94'
RIVER SECTION
12'
200'
EARTH SECTION
16'
16'
12'
75'
123'
PLAN OF LOCK
45'
310'
NIAGARA
ORLEANS
MONROE
WAYNE
CAYUGA
OSWEGO
ONEIDA
HERKI
ERIE
ONONDAGA
SENECA
565.0
564.0
519.5
514.9
512.6
487.5
462.4
446.0
430.0
418.0
398.5
386.0
380.0
374.0
363.0
369.9
395.0
420.0
404.0
383.0
445.0
374.0
335.0
308.0
290.0
270.0
253.5
244.4
Niagara R.
Cross Lake
L. Ontario
Schlirer

Fig. 7.

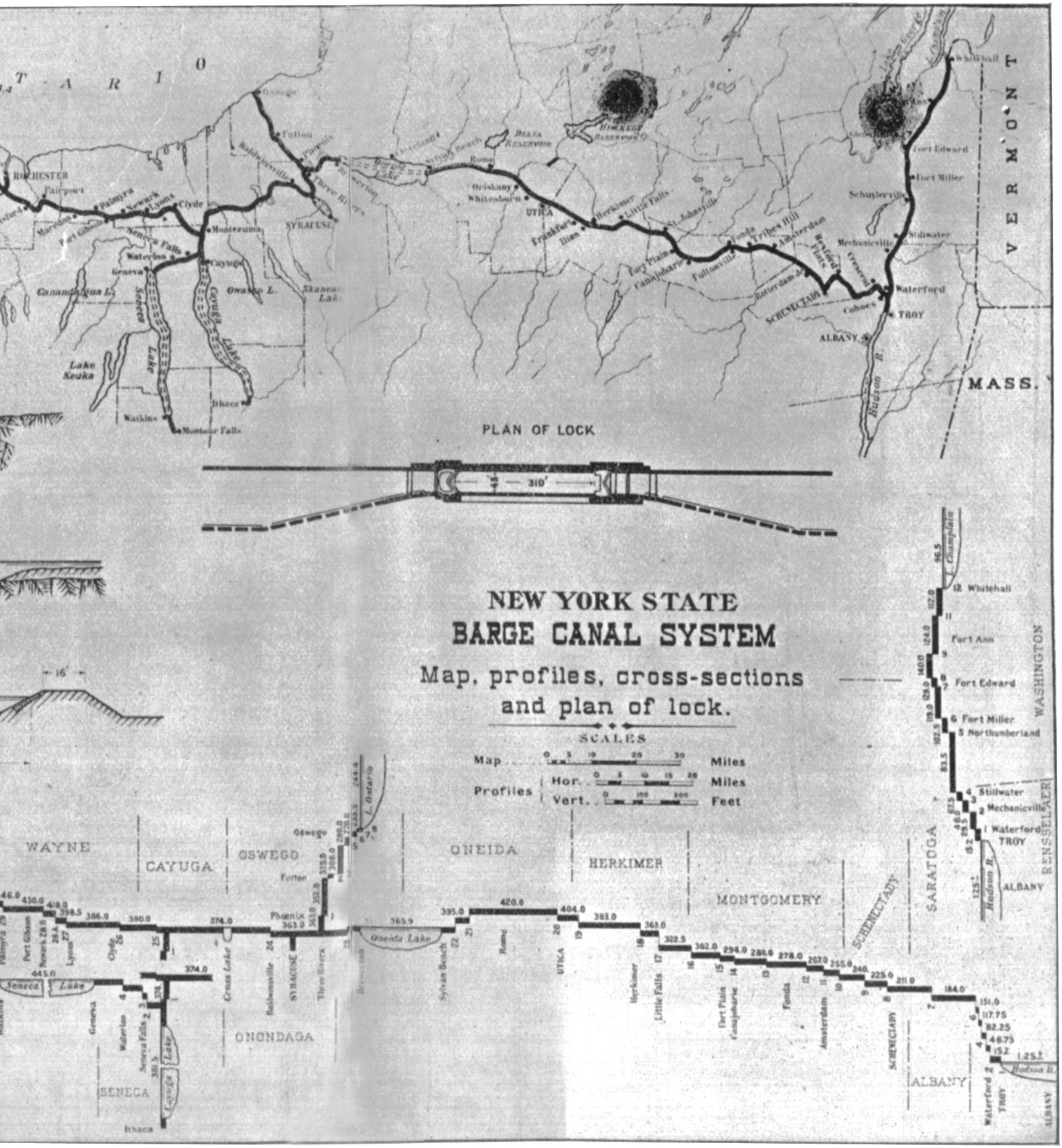
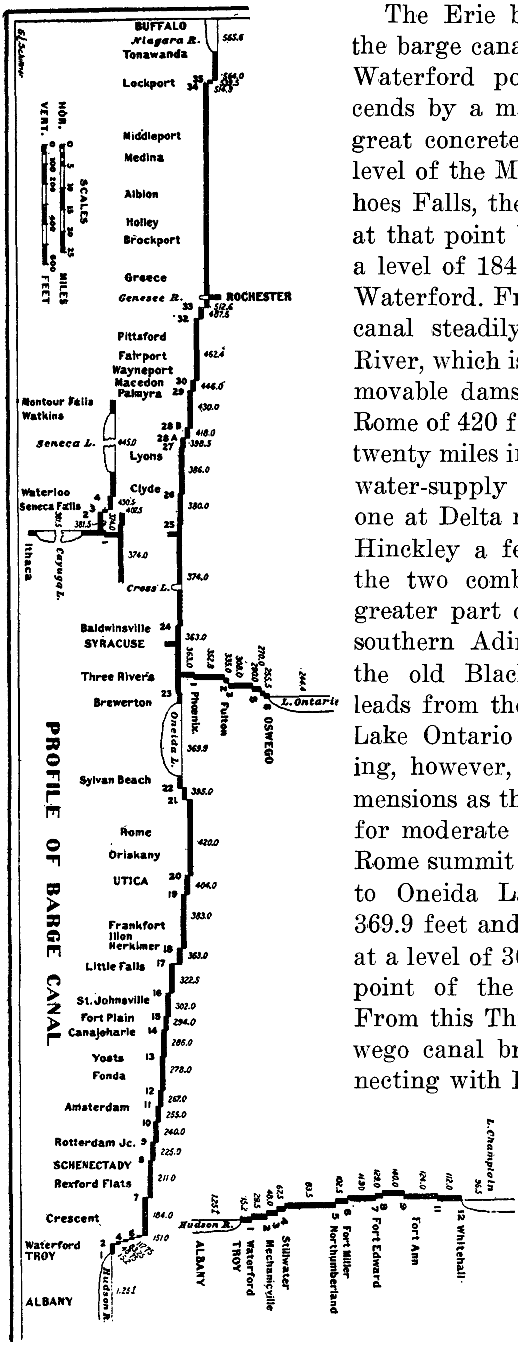

NEW YORK STATE
BARGE CANAL SYSTEM
Map, profiles, cross-sections and plan of lock.
SCALES
Map
Miles
Profiles
Hor.
Miles
Vert.
Feet
PLAN OF LOCK
45'
310'
16'
ONTARIO
VERMONT
MASS.
ROCHESTER
Fairport
Palmyra
Newark
Lyons
Clyde
Macedon
Port Gibson
Seneca Falls
Waterloo
Geneva
Montezuma
Cayuga
Canandaigua L.
Seneca Lake
Cayuga Lake
Owasco L.
Skaneateles Lake
Lake Keuka
Watkins
Montour Falls
Ithaca
Oswego
Fulton
Phoenix
Baldwinsville
Three Rivers
SYRACUSE
Brewerton
Oneida Lake
Sylvan Beach
Rome
DELTA RESERVOIR
HINCKLEY RESERVOIR
Oriskany
Whitesboro
UTICA
Frankfort
Ilion
Herkimer
Little Falls
St. Johnsville
Fort Plain
Canajoharie
Fultonville
Fonda
Tribes Hill
Amsterdam
Rexford Flats
Rotterdam
SCHENECTADY
Crescent
Cohoes
Waterford
TROY
ALBANY
Hudson R.
Mechanicville
Stillwater
Schuylerville
Fort Miller
Fort Edward
Fort Ann
Whitehall
Lake George
L. Champlain
WAYNE
CAYUGA
OSWEGO
ONEIDA
HERKIMER
MONTGOMERY
SCHENECTADY
SARATOGA
WASHINGTON
RENSSELAER
ALBANY
ONONDAGA
SENECA
L. Ontario
Cross Lake
Seneca Lake
Cayuga Lake
Oneida Lake
Hudson R.
420.0
404.0
395.0
383.0
369.9
374.0
363.0
363.0
322.5
302.0
294.0
286.0
278.0
267.0
255.0
240.
225.0
211.0
184.0
151.0
117.75
82.25
46.75
15.2
1.25±
386.0
380.0
398.5
418.0
430.0
445.0
335.0
352.0
308.0
280.0
270.0
246.4
140.0
129.0
124.0
112.0
119.0
107.5
96.5
83.5
67.5
48.5
12 Whitehall
11
Fort Ann
9
8
7 Fort Edward
6 Fort Miller
5 Northumberland
4 Stillwater
3 Mechanicville
2
1 Waterford
TROY
ALBANY
Hudson R.

FIG. 7.



PROFILE OF BARGE CANAL

FIG. 8.

The Erie branch or main line of the barge canal likewise begins at the Waterford pool, from which it ascends by a magnificent series of five great concrete locks and pools to the level of the Mohawk River, above Cohoes Falls, the river being backed up at that point by the Crescent dam at a level of 184 feet, or 169 feet above Waterford. From this point the barge canal steadily ascends the Mohawk River, which is canalized by a series of movable dams, reaching a summit at Rome of 420 feet. This level is nearly twenty miles in length and receives its water-supply from two great dams, one at Delta near Rome, the other at Hinckley a few miles further away, the two combining to impound the greater part of the watershed of the southern Adirondacks. From Rome the old Black River branch canal leads from the barge canal system to Lake Ontario at Watertown, retaining, however, the former limited dimensions as the service of the canal is for moderate local traffic. From the Rome summit level the canal descends to Oneida Lake at an altitude of 369.9 feet and thence to Three Rivers at a level of 363 feet, which is the low point of the central canal section. From this Three Rivers level the Oswego canal branches northward connecting with Lake Ontario at Oswego at an elevation of 244.1 feet. The Oswego canal is of standard barge canal dimensions. From this level also connection is made by a spur leading to the city of Syracuse.

One of the great problems of the barge canal reconstruction, it may be noted, was that of enlarging the canal where it passed through built-up communities, and in the case of both Syracuse and Rochester it was found preferable, owing to excessive damages incident to canal enlargement, to carry the new barge canal well outside those cities and to provide each with a spur.

Westward of the Syracuse level the canal rises to Cross Lake, 374 feet, from which a branch system, provided for by an act adopted in 1909, connects the barge canal with Cayuga and Seneca Lakes. Cayuga Lake is at a level of 381.5 feet, the southern or upper terminus being Ithaca. The Seneca Lake level is 445 feet, the terminus being at Montour Falls, this branch making considerable ascent at Seneca Falls, one of the earliest industrial communities of central New York owing to the water power there developed.

The main line of the barge canal between the Seneca and Niagara Rivers, with the exception of the Rochester cut-off, is merely an enlargement of the old Erie Canal prism. It rises from the Cross Lake level of 374 feet to the Rochester level of 514.9 feet at which the canal maintains a continuous level for more than fifty miles to Lockport, where it meets and ascends the Niagara escarpment and joins the Niagara River at Tonawanda at an elevation of 565 feet. This river being within the jurisdiction of the Federal Government, access to the harbor of Buffalo is had by the so-called Black Rock ship canal, consisting of a great concrete lock and an artificial channel by which the rapids of the Niagara River are avoided and vessels raised from the Tonawanda to the Lake Erie level. The dimensions of the lock are 650 feet long, 70 feet wide and 24 feet deep.

This outline of the barge canal shows, then, that about two-thirds of the new waterway will be new construction and one-third enlargement of the old Erie Canal.

Owing to the length of the route, there are almost innumerable points of engineering interest, of which only a few of the more notable may be here indicated. The Champlain Canal, being mainly a canalization of the Hudson River of shallow section and flowing over rock strata, required much rock excavation. Various methods were employed for this work, including dry excavation within cofferdams, drill boats and under-water blasting, and excavation with dipper drills and rock breakers by which hammers weighing some sixteen tons were so arranged as to be dropped from considerable heights, thus breaking up the rock at the bottom of the channel for removal by dredges.

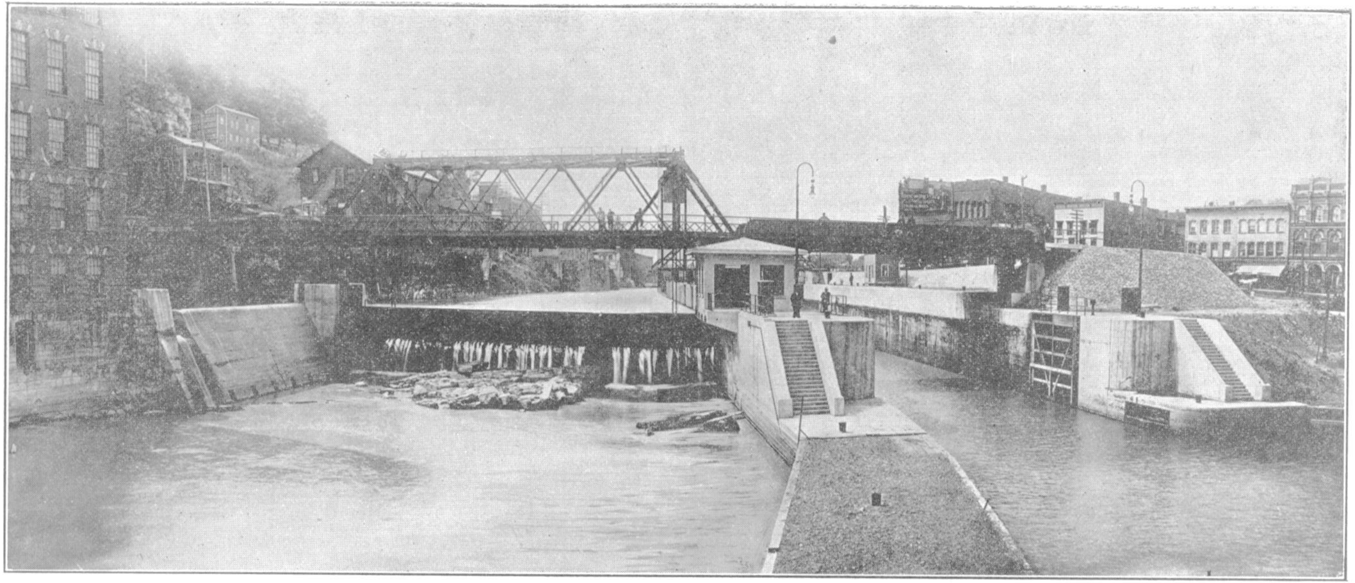


Fig. 9—Barge Canal Terminus, Whitehall, N. Y. Connecting with Lake Champlain. Showing lock and siphon spillway.

An interesting structure on the Champlain Canal is the siphon spillway, originated by the New York engineers. It is designed especially for use in contracted locations where the ordinary long overfall spillway is not feasible. It is operated automatically, both starting and stopping. The summit level of the Champlain Canal is supplied by a feeder from the upper Hudson, and the waterway enters Lake Champlain at Whitehall through a striking combination of structures, including a siphon spillway, a central dam with movable crest, which is operated from a highway bridge spanning the entire structure, and regulates the level of Wood Creek, adjacent to which is lock No. 12 of the canal with its power-house and electric equipment. A bird's-eye view of the canal as it approaches Whitehall is extremely impressive. The completed barge canal makes its way through the valley of Wood Creek in two long reaches, with a single bend, while the creek itself and the old Champlain Canal go wandering around through the valley, crossing and re-crossing the new waterway at several points.

It is, however, on the section of the Barge Canal between Waterford and Oswego that the most impressive work of the entire system is perhaps to be found. The Mohawk River falls over the rock ledge at Cohoes nearly 170 feet before joining the Hudson River. This waterfall—the largest in volume within the state of New York, and one of the most impressive in the country—provides power for the great textile mills and other industries in the vicinity. The old Erie Canal reached Albany by a ditch and numerous locks following the southern bank of the river. The new waterway makes the ascent by following a natural depression that served perhaps in other geological times as the channel of the river, leaving the Hudson north of Cohoes and ascending the valley by the flight of five successive locks to the Crescent dam, already described. One of the features of the canal construction is the safety gate at the Crescent dam level, by which it is made impossible for the flow of the Mohawk River to be diverted in time of flood, or by reason of accident, through the barge canal locks. If such an accident were to happen, it would result in the flooding and probable destruction of the town of Waterford.

The Crescent dam itself, by which the slack-water navigation of the Mohawk River begins, is a great concrete structure having a length of nearly 2,000 feet and a crest thirty-nine feet above the apron. Most of the locks on the barge canal system have individual power-houses for generating power for operating and lighting the lock, each house being equipped with two power units in order that one may be always available. Hand operating devices are also supplied for all machinery in event of accident disabling both power units. These plants are not operated all the time, but only as traffic requires. Water is turned into the turbines when it becomes necessary to operate the lock, and after fifty seconds the power is on ready for operation at full speed.

The next great dam across the Mohawk River is at Vischer's Ferry, this structure also being about 2,000 feet long, the barge canal lock being on the right or southern bank. This dam is not a continuous structure, as the river is separated here into two natural channels by a rocky island, which forms the central section of the dam. Between Schenectady and Little Falls the Mohawk River has been canalized by building eight movable bridge dams of a novel type. These dams maintain pools at the required level during the navigation season, and during the winter the entire structure is elevated and the river flows through its natural channel unimpeded. This prevents destruction of property along the banks, which would be especially severe with the breaking up of the ice at the end of winter. The Boulé gates are raised by means of chains operated by electric winches running on tracks on the bridge floor. These Mohawk dams have either two or three spans, the total lengths ranging from 370 to 590 feet, and the depth of water between sill and upper level varying between 16 and 20 feet.

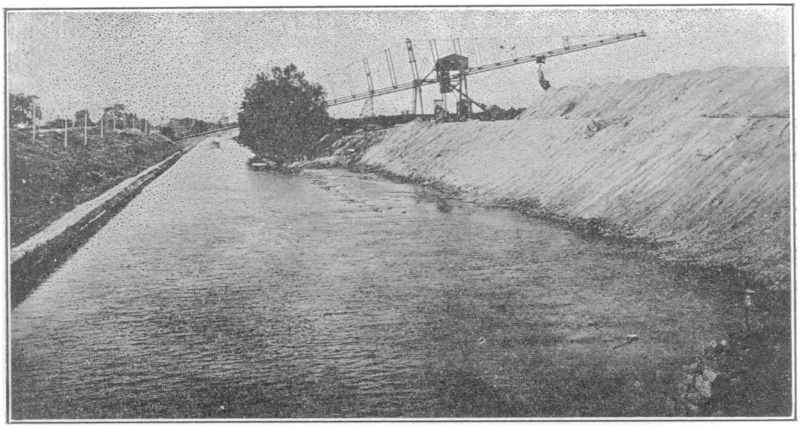


FIG. 10—Enlargement of Erie Canal: section dredge and conveyor.

At Little Falls, always a point of difficulty in canal construction, owing to the narrow defile through which the stream passes and the great hardness of the rock, the barge canal makes the ascent by a single concrete lift lock of extreme elevation (40.5 feet lift), the lower gate of this structure being also of the lift type.

A short distance beyond, at Herkimer, is another movable dam of notable construction, being of the Poirée type. The depth of the pool is regulated by ingenious mechanism.

Under ordinary conditions of rainfall the eastern summit level of the canal, of which Utica and Rome are the focal points, would have an entirely insufficient water-supply, and in order to provide for operation of the canal, two great dams have been constructed, as already explained, to impound the southern Adirondack watershed. The eastern or Hinckley dam is an earth structure 3,700 feet long rising fifty-six feet above the natural surface and creating a reservoir area of 4½ square miles, which drains a watershed of 372 square miles and provides a storage capacity of 3,500,000,000 cubic feet. The Delta dam is a structure of singular beauty, being of masonry connecting sharply rising banks and of unusual height, while a feature of the work is the concrete aqueduct just below the dam by which the Black River canal is carried across the Delta spillway, ascending the farther bank by a flight of three locks adjacent to the dam. This Delta dam is 1,100 feet long, 100 feet high above rock and creates a reservoir of 4⅓ square miles, draining a watershed of 137 square miles and providing storage capacity of 2,750,000,000 cubic feet.

From the Rome summit level the canal descends by two locks to Oneida Lake, left aside by the old Erie Canal, but utilized through its entire length by the barge canal. A few miles west of Oneida Lake, at Three Rivers, the Oswego Canal leaves the main line and descends by eight locks to Lake Ontario. At the northern end of this Oswego branch where it enters the Lake a siphon lock of peculiar design has been built, the only lock of the kind in America and the largest to which that principle has ever been applied. This section of the barge system between Oswego and the Hudson River at Waterford will be the first opened to traffic according to the present plans, and will thus open modern barge communication with Lake Ontario in advance of that with Lake Erie.

In the western section of the canal, the alignment being almost the same as that of the old Erie Canal, the work of improvement has consisted merely in widening and deepening the old channel and providing necessary new walls and structures. The worst difficulties have arisen from leaks and breaks. Near Rochester, for instance, the valley of Irondequoit Creek was filled by embankments and the canal carried over it in a concrete trough. A serious break in this trough forced additional precautions and the lining of adjacent sections of the canal entirely with concrete. Near Rochester also occurs one of the deepest rock cuts along the entire work, while at Medina, about half way between Rochester and Lake Erie, a very interesting construction carries the canal across Old Oak Orchard Creek. Here the Creek flows through a deep gorge which it was originally intended to cross by a long span concrete arch, but finally the old canal route circling the gorge was preferred and this required the construction of a high retaining wall, so that the barge canal runs for about one-third of a mile behind a dam forty-five feet high. At Lockport the canal rises from the Ontario to the Erie level ascending the Niagara escarpment. Here the old Erie Canal made the ascent of forty-nine feet by a double flight of five locks each, or ten altogether, which, when first built, were one of the wonders of the country, and although long ago outgrown, were always a noteworthy example of lock construction. Here the State engineers have retained for local use one of the parallel flights of five locks, while the other flight has been entirely torn away, the under-lying rock blasted out and the ascent made by building two barge canal locks of standard dimensions. While the symmetry of the old double flight is thus quite ruined, the presence

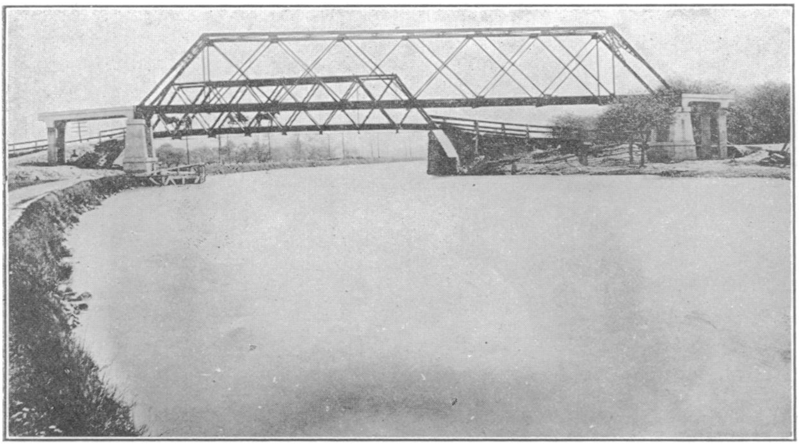


Fig. 11—Section of canal showing enlargement of prism and new standard bridge as compared with old Erie Canal bridge.

of both the old and the new locks side by side forms a permanent object lesson of the vast growth in American commerce during a single century of national development, and small boats will be enabled to pass through the locks without calling for the use of the great amount of water needed to operate the standard barge canal locks.

The ridge above Lockport is composed of rock and the excavation of a channel through this rock was a very interesting piece of work, being carried on with a battery of channelers and a double boom conveyor working in conjunction with a steam shovel. It was on this westernmost section of the canal that the heaviest work was necessary.

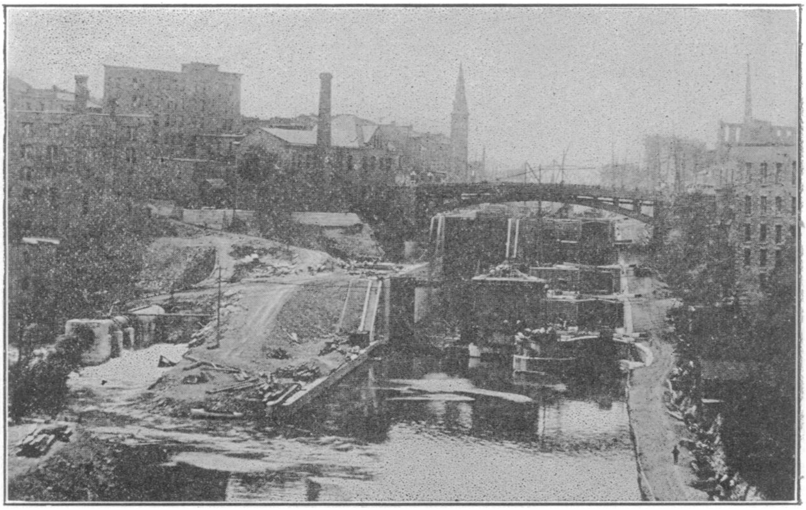


FIG. 12—Locks at Lockport, N. Y. Erie Canal locks at right, Barge Canal locks at left.

The terminus of the new barge canal is at its junction with the Niagara River at Tonawanda, except that the old Erie Canal in Buffalo is retained for local harbor and canal purposes. The passage of the rapids in the Niagara River between Tonawanda and Buffalo is effected by the Federal Black Rock Harbor and Channel, which was completed and opened to traffic at the end of 1914. This is really a canal built along the east bank of Niagara River, but separated from the main stream by a pier and island. The original channel was built as a terminal for the Erie Canal, being four miles long and 200 to 400 feet wide. The present improvement provides a deep draft channel 200 feet wide and 23 feet deep, joining at

Buffalo the 23-foot channel there completed in 1908. After passing through the great concrete ship lock which overcomes the rapids in the river, the channel extends about two and a half miles, 400 feet wide, to deep water above Tonawanda, at a total cost of about $4,500,000. The work of constructing this Black Rock ship lock was done inside a great coffer-dam made of interlocking sheet steel piling, and owing to the very large dimensions of the coffer-dam, and the great resistance which it overcame, this was regarded by engineers as the most important sheet piling structure ever built.

The dimensions of the Black Rock ship lock are 650 ft. long, 70 ft. wide and 24 ft. deep.

Barge Canal traffic reaching Buffalo is, of course, protected from Lake Erie by the Government harbor structures. The original port at Buffalo was the narrow winding Buffalo Creek. The entrance from the Lake was shallow and frequently closed by bars. In later years the harbor works were greatly extended. The inner river and canal and basin harbor is now about seven miles long and 200 feet wide, project depth being 23 feet. At the southern end of this outer harbor great steel works have been built, which utilize the Lake Superior ore at the eastern limit of Great Lakes navigation.

The plans for the barge canal have proceeded on an estimated seasonal traffic of 10,000,000 tons, but providing capacity for handling a maximum traffic of 18,500,000 to 20,000,000 tons per season.

BARGE CANAL STATISTICS

The entire barge canal undertaking is summarized in the following statistics:

Erie branch, length of canal, not including Hudson and Niagara river termini............	323.4 miles
Erie branch, number of locks..................	35
Oneida Lake, not included in above mileage, no improvement needed......................	about 19 miles
Spurs to Erie branch (Rochester and Syracuse harbors, including Onondaga lake)..........	9.1 miles
Champlain branch, length of canal..............	61.5 miles
Champlain branch, number of locks............	11
Oswego branch, length of canal................	22.8 miles
Oswego branch, number of locks...............	7
Cayuga and Seneca branch, length of canal (including spurs at heads of lakes)...........	27.5 miles
Cayuga and Seneca branch, number of locks.....	4
Cayuga and Seneca lakes, portions needing no improvement and not included in above mileage	65 miles

Width of channel, land line, earth section, bottom, minimum	75	feet
Width of channel, land line, earth section, water-surface	123 to 171	feet
Width of channel, land line, rock section, bottom, minimum	94	feet
Width of channel, river line, bottom, generally	200	feet
Depth of channel, land line and minimum river line	12	feet
Locks, length between gates	338 to 343	feet
Locks, length of chamber—available length	311	feet
Locks, width of chamber	45	feet
Locks, depth of water on sills	12	feet
Dams, new	30	
Dams, old, with new crests	5	
Dams, old, used without change	5	
Bridges	199	
Boats, capacity, using full lock width	about 3000	tons
Boats, capacity, built for two to pass in most restricted channel and for two, traveling tandem, to be locked at one lockage	about 1500	tons
Authorization of work (Erie, Champlain and Oswego canals)	Chapter 147, Laws of 1903	
Authorization of work (Cayuga and Seneca canal)	Chapter 391, Laws of 1909	
Appropriation (Erie, Champlain and Oswego canals)	$101,000,000	
Appropriation (Cayuga and Seneca canal)	$7,000,000	
Construction work begun (Champlain canal)	April 24, 1905	
Construction work begun (Erie canal)	June 7, 1905	
Excavation, preliminary (1903) estimate, not including work for dams, bridges, highways, railway, and steam changes and other small items (Erie, Champlain and Oswego canals)	132,225,800	cu. yds.
Excavation, contract plans (Erie, Champlain and Oswego canals), approximate	105,239,000	cu. yds.
Excavation, contract plans (Cayuga and Seneca canal), approximate	10,592,000	cu. yds.
Concrete, preliminary (1903) estimate (Erie, Champlain and Oswego canals)	3,243,100	cu. yds.
Concrete, contract plans (Erie, Champlain and Oswego canals), approximate	2,698,000	cu. yds.
Concrete, contract plans (Cayuga and Seneca canal), approximate	196,000	cu. yds.†

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† In the concluding part of this paper the author will discuss the canal traffic, past, present and prospective.

(To be concluded)